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ABSTRACT

The focus of this paper is to present non-traditional or alternate instructional methods in remedial mathematics education at the community college level. However, these methods will apply to credit math courses as well as courses from other disciplines. With the large number of students needing remediation and the United States traditionally scoring low on international tests, educators at the community college level face the challenge of rethinking the curriculum and methods of instruction. Many students entering the community college are at a lower level academically because of lack of motivation, self-esteem, and maturity. The paper argues that community college instructors can make some differences in the classroom by altering their teaching methods to accommodate different learning styles. It introduces Ice Breakers as an essential instructional technique in the classroom because they create a relaxed atmosphere and diminish the feeling of inherent isolation in commuting students. This is a useful exercise because students find other students with similar interests, and it is also very revealing because often what is voiced in the remedial class is the fear of mathematics and the fear of failing. The article describes cooperative learning and gives an example of a totally cooperative classroom. The paper also discusses small versus large class learning styles and instructional methods, and the role of technology, computers, and the Internet. (VWC)

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NON-TRADITIONAL INSTRUCTION

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INTRODUCTION

The focus of this paper is to present non-traditional or alternate instructional methods in remedial mathematics education at the two year level, however, these methods will apply to credit math courses as well as courses from other disciplines. With the large number of students needing remediation and the United States traditionally scoring low on international tests, we at the community college level face the challenge of rethinking our curriculum and our methods of instruction.

THE PROBLEM:

According to a study in 1995 by the U.S. Department of Education, 78% of higher education institutions offered remedial writing courses and 72% offered remedial mathematics courses. The percent of all entering first time freshmen, in all United States colleges, that enrolled in either a reading, writing or math course was 29. However, at two-year public institutions 41% enrolled in remedial courses and overall more first time freshmen enrolled in remedial mathematics (34%), then writing (25%) and reading (20%). At Middlesex County College, we run approximately 80 sections per semester of basic mathematics and algebra, which is comparable to community colleges across the United States. The Third International Mathematics and Science Study conducted in 1994-1995 shows the average score of a thirteen year old in mathematics was 500 with Singapore finishing first (643), South Korea second (607), Japan third (605), France thirteenth (538) and the United States twenty-eighth (500). As part of the TIMSS assessment, classroom instruction was video taped and differences were discovered. According to "The TIMSS Videotape Study," American

Educator, American Federation of Teachers, one of the main differences between math education in Japan and the Unites States is the approach to instruction. U.S. instructors teach a skills-based curriculum in which students learn by example and repetition. Japanese instructors use a problem-based curriculum; they believe students should struggle with a problem first, make mistakes, and reflect on their errors before it is possible for them to understand the topic. An article in the *New York Times* by Edward Robinson, "Technology", contained this problem on the TIMSS twelfth grade advanced mathematics test: "A string is wound symmetrically around a circular rod. The string goes exactly four times around the rod. The circumference of the rod is 4 cm. and its length is 12 cm. Find the length of the string. Show all your work." Although this question requires only basic math and geometry principles, this was one of the hardest questions on the test. Only 12% of all students got at least part of the problem correct with 10% solving it. However, the average for the United States students was 4% for a complete solution, with no significant partial solutions.

THE STUDENTS

The students who attend community colleges in the United States come with diverse academic and ethnic backgrounds and maturity levels. We have the adult student who is self-motivated, but finds he or she may need remediation due to a lapse of time in his or her formal education. We also have the students who need no remediation but see the community college as an inexpensive alternative to higher education. The majority of students, however, are there because either their academic

record is poor not allowing entrance into a four year school, or they really don't know if they want to attend college and are giving it a try (usually under parental pressure), or their maturity level does not lend itself to a four year college. Most likely it is a combination of all of the above. Many students have poor study habits because in high school they only studied enough to "get by." In mathematics especially, students enter with a math anxiety; after many years of poor performance they are convinced they can not comprehend the material. They enter the community college not only thinking they are inferior to students entering four year institutions due to their past performances, but also due to the misconception of the community college, fostered by high school personnel and four year college administrators, that two-year colleges are an inferior product. Many students are at a lower level academically not necessarily because of intelligence, but because of a lack of motivation, self-esteem and maturity.

LEARNING STYLES

We all have our individual style of learning. Some of us learn in many ways but we retain more if what is learned is acquired in the style to which we are attuned. Learning style is the way people concentrate on, internalize and remember new and difficult knowledge or skills (R. Dunn and K. Dunn, *Teaching Students Through Their Individual Learning Styles:A Practical Approach*, Englewood Cliffs, N.J. Prentice-Hall, 1978). It is composed of cognitive, motivational, and physiological elements that affect each person's ability to perceive, interact with, and respond to the learning environment (J.W. Keefe, "Assessment of Learning Style

Variables The NASSP Task Force Model." *Theory into Practice* 24(1985) 138-43 The four main learning styles are visual, aural, reading/writing, and kinesthetic For example, in a questionnaire to assess ones learning style, a sample question is "You are about to give directions to your house to a friend staying at a hotel, would you a draw a map, *(visual)* b write directions, *(reading writing)* c tell the directions, *(aural)* or d offer to drive to the hotel and take your friend to your house *(kinesthetic)*." At the end of the questionnaire students are given instructions on tallying the results and offered suggestions on how to alter their study skills in order to maximize their capacity for learning and retaining material (Fleming, N D., & Mills,C (1992) Not another inventory, rather a catalyst for reflections *To Improve the Academy, 11,* 137-155) It is beneficial for every student to understand which is his or her natural learning style

INSTRUCTIONAL METHODS

What role does the community college instructor play in educating under prepared students with varied learning styles? I believe that we can make some difference in the classroom by altering our teaching methods to accommodate different learning styles We must be willing to experiment with new venues of instructional methodology and approach such methodology with an open mind The following is an instructional technique that I have found useful in my classes

Ice Breakers I believe Ice Breakers are essential in a community college classroom because they create a relaxed atmosphere and diminish, to a degree, the feeling of isolation inherent in commuting students There are many books devoted to the topic

of ice breakers. I offer the following, which I learned at a workshop and I use in all my classes. I group students in twos, threes, or fours and I ask them to get to know each other. I also tell them this might be a good time to exchange telephone numbers and many do. After they talk for about ten minutes, I ask someone in the group to introduce another person in the group to the class and tell something about that person. Everyone in the class has a chance to speak. This is a useful exercise because students find other students with similar interests, but it is also very revealing because often what is voiced in the remedial class is the fear of mathematics and the fear of failing. This expression of fear allows me to establish, on day one, a positive attitude towards a new beginning in the learning of mathematics and my belief that they can learn the material through hard work. Besides creating a non-threatening atmosphere, the ice-breaking technique lends itself nicely to cooperative learning activities which I also use on the first day.

COOPERATIVE LEARNING

Because much has been written about cooperative learning over the past ten years, many instructors believe this is not an alternate instructional method, but rather a traditional method. However, I met many instructors at national mathematics conferences who have not tried cooperative learning in their classes and some that are unwilling to try it at all. Workshops on this topic are always in demand. Instructors want to know what is this panacea for mathematics education and how will it transform students into eager learners. Cooperative learning should not be looked on as a cure-all to mathematics education but rather as a technique, along with other

techniques, that can be used to motivate, and in many instances, stimulate critical thinking. Although cooperative learning is touted as a new approach to education, two instances in which team learning was implemented in my elementary education are prominent in my mind. One was in geography when the class worked together on a project on Alaska and another was a writing assignment in which we had to read and help edit each other's papers. The fact that these are my main memories of my elementary years illustrates what a powerful tool cooperative learning can be. In addition to a valuable educational technique, it is also what industry wants. When asked what employability skills were important to succeed in industry, employers responded with answers such as: listening and oral communication, competence in reading writing, and computation, creative thinking and problem solving, and group effectiveness (Workplace basics: The skills employers want (1988). American Society for Training and Development and the U.S. Department of Labor. According to Karl A. Smith, a noted lecturer on cooperative learning from the University of Minnesota, "Cooperative learning involves people working in teams to accomplish a common goal, under conditions that involve both positive interdependence and individual and group accountability." Cooperative learning activities must be carefully structured to insure total involvement. Guidelines and evaluation must be explicit. What activities are appropriate for cooperative learning? We just have to look to Japan for one possibility. Japan uses a problem solving approach to introduce lessons. For example, when addition of fractions is taught in Japan the students are not told the correct method to use but instead are given problems to struggle with. The teacher then compiles the methods, and together with

the instructor the students rule out inappropriate methods, and determine the correct method of solution (TIMSS Videotape Study). Any class, large or small, remedial or advanced lends itself in some way to cooperative learning.

A TOTALLY COOPERATIVE CLASSROOM

At Middlesex County College we are presently offering sections of Freshman Mathematics that are being taught collaboratively. The object of the course is to learn mathematics through problem solving. The course is composed of a series of problems, and students must solve these problems cooperatively using strategies that are introduced throughout the semester. The problems are divided into two sets. Set A is done in class cooperatively and set B is done outside of class, either individually or cooperatively, and submitted for a grade. I sat in on one class this semester and the following are my observations.

When I arrived at Professor Boyd-DeMarzio's Freshman Math Class the students were in groups discussing a previously worked problem. When one group was called upon to present their problem they comfortably went to the front of the room to start the discussion. The instructor took a seat with the students. One student read the problem.

> Harum and her friends went to play on an island about 1/4 mile offshore at the lake. The small sailboat available to them can only take 220 pounds at a time. Harum weighs 120 pounds, Sam weighs 100 pounds, Eliza weighs 95 pounds, Carman weighs 110 pounds, and Les weighs 140 pounds. How many trips does it take to get them off the island? (Problem Solving Strategies: Crossing

the River With Dogs and Other Mathematical Adventures, Ted Herr & Ken Johnson, Key Curriculum Press 1994.

One student went to the board and started the explanation listing the restrictions on the boat as they pertained to the people in the problem. The other students in the group acted out the problem as the narrator continued the explanation. As the group presented their findings, the rest of the class was involved either as counters for the number of trips or as listeners to make sure the boat did not capsize. The group completed the problem successfully using seven trips. Afterward the presentation was open to questions and comments and other students offered different ways of solving the problem. The problem was then reevaluated to determine the minimum number of trips to achieve the desired results. During this session the instructor acted as facilitator. Rather than explaining the answers, her comments were: "I don't understand... you must show me... you must explain in detail." When I interviewed Professor Boyd-DeMarzio after class, she stated the purpose of the course is to develop specific problem solving strategies and communication skills, and also to foster an enjoyment of math. Do the students in this situation enjoy math? According to a survey written by Dr. Luke, Dean of Heath Technologies, Science, and Mathematics at Middlesex County College, and administered to all students taking Freshman Mathematics, 78% reported a changed attitude toward mathematics, with comments such as: "less fearful of math,... math seemed more practical,... first time I really enjoyed a math class." An interesting comment on the survey was students felt that the group depended on them therefore attendance was important. In fact, 95% said that attendance was important and 94% said they would recommend

the class to other students, although some cautioned only if they felt the student had the ability, while others stated only if the student liked to work in groups.

THE SMALLER CLASS.

Although the above model seems to work well, many subjects, especially in mathematics, do not lend themselves to total cooperative learning. The struggle exists between "covering the material" and the amount of time needed to successfully challenge students to discover the information. To allow for different learning styles in the small classroom, I suggest using teaming projects throughout the semester in conjunction with lecturing. The following is a math problem I have used prior to any discussion of maximum value.

> The ABC Company, which you work for, manufactures widgets. Your department has been commissioned to determine the dimensions of the rectangular open box that should be used to maximize the number of widgets that can fit into each box. If the piece of cardboard available measures 8 1/2 by 11 in. find the measurement of the largest open box that can be formed.

When students first see this problem they do not know how to begin. They do not realize that they have the material in front of them and that they can physically cut the material. They always ask what the formula is, or how do we start this. I tell them to read the directions and discuss options with members in their group. As the groups realize that they need scissors and rulers, I supply them. As I sit with each group we determine reasonable cuts to make and assignments to give each group member. After all groups finish, they report on the findings and arrive at the answer. I then

introduce the appropriate mathematical techniques, depending on the class, and we see that the answer we arrived at experimentally is very close to the actual answer. One of the difficult parts of using cooperative learning for an instructor is not to tell the students how to proceed but to wait and give support by asking leading questions.

THE LARGE CLASS

Lecture has become an unwelcome word in modern pedagogy but we cannot totally abandon lecture in the classroom. Knowledge must be disseminated in some fashion, whether through reading, seeing, doing, or hearing. If we are to truly allow for individual differences, the lecture must remain a part of education since many people are auditory learners. Total lecture, however, is no longer as effective as it once was. There are various theories for this, ranging from our technological society with its instant gratification to a lessening of self-discipline in general. Whatever the reason, effective classes must utilize different teaching strategies. What then can be done with the large lecture class? At I workshop I attended, Karl Smith, illustrated a film of a physics lecture class containing about 200 students. In the middle of the lecture the professor stopped and asked students a yes/no question on the material he had just taught. The students were instructed to register their vote with a show of hands. The answers were mixed. The professor then asked each student to confer with someone sitting next to him or her and come to an agreement on the answer. He then called for another show of hands and the correct answer was given by the majority of students. This activity took a small amount of time but it gave students a chance to comprehend, digest, and process the information just presented.

TECHNOLOGY

As we enter the twenty-first century, technology is advancing in leaps and bounds. We as educators are in the process of defining what role technology will play in the classroom. Graphing calculators have been commonplace for the past six years, yet many schools have not incorporated them into their curriculum. Graphing calculators are a good tool for visual learners. Calculators and group work can go hand in hand. Consider the following learn by discovery problem using the graphing calculator.

1. Graph $y = x^2$, $y = \frac{1}{3}x^2$, $y = \frac{1}{2}x^2$, $y = \frac{3}{4}x^2$, $y = 5x^2$, $y = 10x^2$ and $y = 24x^2$ on the same coordinate system.

2. Decide how the coefficient of x^2 affects the graph.

3. Describe how the graph of $y = a x^2$ can be obtained from the graph of $y = x^2$, where a is a number greater than zero for: a. $0 < a < 1$ b. $a > 1$

Students are able to do the first part of the problem alone but need guidance to make the transition to the more abstract parts. After the functions are graphed most groups ask what is meant by questions 2 and 3? What is expected of us? For step two I encourage each group to discuss the effect of the coefficient and to write their findings. For step three I tell them to generalize what the have just learned. Most students complete the activity without confidence in their understanding. The major benefit comes later when transformations of other functions are discussed. The student realizes what should happen to the other functions because he/she retains the knowledge learned by discovery. As one student told me, " I just see it as all the same except that the function changes."

COMPUTERS AND THE INTERNET

Middlesex County College currently offers computer assisted instruction for Basic Mathematics and Elementary Algebra. The courses are taught by an instructor in conjunction with Academic Systems interactive software. The student hears the lesson using headphones. The student is asked to interact many times during the lesson and at the end of the session takes a test on the material presented. The instructor receives the test score and decides if the student needs personal attention or is able to proceed to the next lesson. Preliminary results show that although the passing rate in courses using the computer is unchanged compared to traditional courses, students using the computer are receiving higher grades. The role of the instructor is different in computer assisted instruction. The instructor interacts one on one, or in small groups with the student. Student reactions to the class are mixed. Students who felt the course would be easier than a traditional course invariably did not do well. Positive comments from students were that they liked working at their own pace and could go back to redo anything that they did not understand. One main negative comment from students was that they missed the classroom atmosphere where they were able to ask questions and interact with an instructor.

This semester Middlesex County College will be offering courses on the Internet. Computer assisted and Internet courses are being offered to allow students who prefer to work on their own a choice. These courses are probably for a small portion of the student body, but are necessary to give all students the opportunity to achieve success using all feasible learning styles.

CONCLUSION

With any new paradigm in education there is controversy. Some questions are: is the material being covered, is technology used as a tool or being relied on by the student, and how is group work evaluated? These are legitimate questions and must be constantly reevaluated. The key, I believe, is the education of faculty. Workshops are needed, not on how to use the calculator, but how to effectively use it in various mathematics classes. Workshops on teaming that are relative to one's discipline are necessary. Time must be set aside to allow faculty to discuss and exchange ideas. We must not be afraid to break from tradition and try new approaches. If some material is not being covered because of teaming activities, then we must reevaluate our curriculums. At a recent seminar, I remember asking "How can we use teaming activities and still cover the material", Karl Smith replied that it depends on who is covering the material and who is learning the material. In conclusion I would like to share comments I have heard from students after classes that contained non-traditional instruction: "I never knew math could be fun.," or "I finally understand math."